

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Listing of Claims:

1. (Currently Amended) An etching apparatus for etching a glass substrate comprising:
 - a first tank including a first etchant;
 - an etch bath having a bubble plate, the glass substrate immersed in the first etchant and the etch bath connected to the first tank and receiving the first etchant, the etch bath containing a residual etchant including a diluted etchant and residue material after the glass substrate is etched with the first etchant, wherein a thickness of the glass substrate is uniformly reduced;
 - a second tank receiving the residual etchant from the etch bath and separating the diluted etchant from the residue material;
 - a connecting passage directly connecting the first and second tanks and directly transferring the separated diluted etchant from the second tank to the first tank;
 - an outlet pipe attached to the second tank, the outlet pipe discharging the residue material; and
 - a control unit controlling the first tank, the etch bath and the second tank, the control unit terminating the etching when a temperature of the first etchant reaches a termination temperature ~~measuring and receiving a signal indicating the temperature of the etchant from a temperature sensor and transmitting an etching termination signal to the etch bath when the temperature reaches a target temperature; wherein an etched thickness of the glass substrate is derived from the temperature of the first etchant, and wherein the total reaction energy is used as a reference.~~

2. (Previously Presented) The etching apparatus according to claim 1, wherein the etch bath includes a temperature sensor for sensing a target temperature to stop etching the glass substrate.
3. (Original) The etching apparatus according to claim 1, further comprising:
a rinse bath for cleaning the substrate that is etched in the etch bath; and
a dry bath for drying the substrate that is rinsed at the rinse bath.
4. (Original) The etching apparatus according to claim 1, further comprising:
an etching solution source for supplying an etching solution to the first tank; and
a water supply for supplying water to the first tank.
5. (Previously Presented) The etching apparatus according to claim 4, wherein the first tank includes a first amount of the first etchant of a concentration from the etching solution, a second amount of the water, and a third amount of the diluted etchant.
6. (Original) The etching apparatus according to claim 4, wherein the etching solution includes HF solution.
7. (Original) The etching apparatus according to claim 1, wherein the first tank includes a concentration measuring device measuring a concentration of a resultant etchant.
8. (Original) The etching apparatus according to claim 1, further comprising a pump connected to the connection passage for pumping the diluted etchant from the second tank to the first tank.

9. (Previously Presented) The etching apparatus according to claim 1, wherein the outlet pipe is connected to a bottom of the second tank, and the bottom portion of the second tank has a cone shape.

10. (Currently Amended) An etching apparatus for etching a glass substrate with an etchant, comprising:

an etch bath receiving the substrate immersed into the etchant, the etch bath etching the glass substrate, wherein thickness of the glass substrate is uniformly reduced;

a temperature sensor installed in the etch bath, the temperature sensor measuring and monitoring a temperature of the etchant while the glass substrate is etched in the etch bath; and

a control unit controlling the etch bath, the control unit connected to the temperature sensor for receiving a signal indicating a temperature of the etchant to terminate the etching when the temperature of the etchant reaches a termination temperature ~~measuring and receiving a signal indicating the temperature of the etchant from the temperature sensor and transmitting an etching termination signal to the etch bath when the temperature reaches a target temperature;~~
~~wherein an etched thickness of the glass substrate is derived from the temperature of the first etchant, and wherein the total reaction energy is used as a reference.~~

11. (Currently Amended) An etching apparatus for etching a glass substrate comprising:

a first tank including a first etchant;

an etch bath having a bubble plate, the glass substrate immersed in the first etchant and the etch bath connected to the first tank receiving the first etchant and etching the substrate with the first etchant wherein a thickness of the glass substrate is uniformly reduced, the etch [[both]]

bath producing a residual etchant including a diluted etchant and residue material as a result of etching the substrate;

a separation tank receiving the residual etchant from the etch bath and separating the diluted etchant from the residue material using gravity of the residue material, the separation tank directly transferring the separated diluted etchant to the first tank;

a rinse bath cleaning the glass substrate that is etched in the etch bath;

a dry bath drying the glass substrate that is rinsed at the rinse bath;

a solvent supply source supplying solvent water to the first tank;

an etching solution source supplying an etching solution to the first tank; and

a control unit controlling the etch bath, the rinse bath, the dry bath, the first tank, and the separation tank;

wherein an etched thickness of the glass substrate is derived from the temperature of the first etchant, and wherein the total reaction energy is used as a reference.

12. (Original) An etching apparatus according to claim 11, wherein the control unit controls the etch bath, the rinse bath, the dry bath, the first tank, and the separation tank such that each of the etch bath, the rinse bath, and the dry bath operates a corresponding process with respect to a plurality of substrates at substantially the same time.

13. (Previously Presented) The etching apparatus according to claim 11, further comprising a temperature sensor installed in the etch bath for monitoring a temperature of the first etchant while the substrate is etched in the etch bath, wherein the control unit receives signals indicating the temperature of the etchant from the temperature sensor and transmitting an etching termination signal to the etch bath when the temperature reaches a target temperature to

terminate the etching of the substrate.

14. (Previously Presented) The etching apparatus according to claim 13, wherein the control unit receives signals indicating the temperature of the etchant at start of etching the glass substrate in the etch bath and processes the signals to derive the target temperature of the etchant.

15. (Previously Presented) The etching apparatus according to claim 11, wherein the first tank contains the first etchant from a mixture of the etching solution, the solvent water, and the diluted etchant.

16. (Original) The etching apparatus according to claim 11, further including a concentration measuring device installed in the first tank for measuring a concentration of the first etchant.

17. (Original) The etching apparatus according to claim 11, wherein the etching solution includes HF solution.

18. (Original) The etching apparatus according to claim 11, further comprising a discharging pipe connected to the first tank, the etch bath, the separation tank, and the rinse bath.

19. (Previously Presented) The etching apparatus according to claim 1, wherein the bubble plate is located at a bottom portion of the etch bath and produces nitrogen bubbles.

20. (Previously Presented) The etching apparatus according to claim 10, wherein the etch bath includes a bubble plate producing nitrogen bubbles from a bottom portion of the etch bath.

21. (Currently Amended) An etching apparatus for etching a glass substrate comprising:

a first tank including a first etchant;

an etch bath, the etch bath having a bubble plate generating nitrogen bubbles, the glass substrate immersed in the first etchant and the bubble plate connected to a nitrogen inlet pipe, the nitrogen inlet pipe connected to a nitrogen supply line, the etch bath connected to the first tank and receiving the first etchant, the etch bath containing a residual etchant including a diluted etchant and residue material after the glass substrate is etched with the first etchant, wherein a thickness of the glass substrate is uniformly reduced;

a second tank receiving the residual etchant from the etch bath and separating the diluted etchant from the residue material;

a connecting passage connecting the first and second tanks directly transferring the separated diluted etchant from the second tank to the first tank;

an outlet pipe attached to the second tank discharging the residue material; and

a control unit controlling the first tank, the etch bath and the second tank, the control unit terminating the etching when a temperature of the first etchant reaches a termination temperature measuring and receiving a signal indicating the temperature of the etchant from a temperature sensor and transmitting an etching termination signal to the etch bath when the temperature reaches a target temperature; wherein an etched thickness of the glass substrate is derived from the temperature of the first etchant, and wherein the total reaction energy is used as a reference.

22. (Currently Amended) An etching apparatus for etching a glass substrate with an etchant, comprising:

an etch bath receiving the glass substrate immersed into the etchant etching the glass substrate, wherein a thickness of the glass substrate is uniformly reduced;

a temperature sensor installed in the etch bath measuring and monitoring a temperature of the etchant while the glass substrate is etched in the etch bath; and

a control unit controlling the etch bath, the control unit connected to the temperature sensor for receiving a signal indicating a temperature of the first etchant to terminate the etching when the temperature of the first etchant reaches a termination temperature, wherein the temperature of the first etchant varies in accordance with a reaction heat generated from etching the glass substrate, and the termination temperature of the first etchant depends on total reaction energy measuring and receiving a signal indicating the temperature of the etchant from the temperature sensor and transmitting an etching termination signal to the etch bath when the temperature reaches a target temperature; wherein a reaction heat generated from etching the glass substrate changes the temperature of the etchant; wherein an etched thickness of the glass substrate is derived from the temperature of the first etchant; and and wherein the total reaction energy is used as a reference.

23. (Currently Amended) An etching apparatus for etching a glass substrate comprising:

a first tank including a first etchant;

an etch bath having a bubble plate generating nitrogen bubbles, the glass substrate immersed in the first etchant and the bubble plate connected to a first nitrogen inlet pipe, the nitrogen inlet pipe connected to a nitrogen supply line, the etch bath connected to the first tank receiving the first etchant and etching the substrate with the first etchant, wherein a thickness of the glass substrate is uniformly reduced, the etch bath producing a residual etchant including a diluted etchant and residue material as a result of etching the substrate;

a separation tank receiving the residual etchant from the etch bath separating the diluted etchant from the residue material using gravity of the residue material, the separation tank directly connected to the etch bath via an etchant outlet pipe, the separation tank directly transferring the separated diluted etchant to the first tank;

a rinse bath cleaning the glass substrate that is etched in the etch bath;

a dry bath drying the glass substrate that is rinsed at the rinse bath;

a solvent supply source supplying solvent water to the first tank;

an etching solution source supplying an etching solution to the first tank; and

a control unit controlling the etch bath, the rinse bath, the dry bath, the first tank, and the separation tank;

wherein an etched thickness of the glass substrate is derived from the temperature of the first etchant, and wherein the total reaction energy is used as a reference.

24. (Previously Presented) The etching apparatus according to claim 23, further comprising a heater for supplying heat is installed at a side of the dry bath.

25. (Previously Presented) The etching apparatus according to claim 11, further comprising a temperature sensor installed in the etch bath for monitoring a temperature of the first etchant while the substrate is etched in the etch bath, wherein the control unit receives signals indicating the temperature of the etchant from the temperature sensor and transmitting an etching termination signal to the etch bath when the temperature reaches a predetermined target temperature to terminate the etching of the glass substrate, and wherein a reaction heat generated from etching the glass substrate changes the temperature of the etchant.

26. (New) An etching apparatus for etching a glass substrate comprising:

a first tank including a first etchant;

an etch bath connected to the first tank and receiving the first etchant, the etch bath containing a residual etchant including a diluted etchant and residue material after the glass substrate is etched with the first etchant;

a second tank receiving the residual etchant from the etch bath and separating the diluted etchant from the residue material using gravity of the residue material;

a connecting passage connecting the first and second tanks for transferring the separated diluted etchant from the second tank to the first tank;

an outlet pipe attached to the second tank, the outlet pipe discharging the residue material;

a temperature sensor sensing a temperature of the first etchant; and

a control unit receiving a signal indicating the temperature of the first etchant from the temperature sensor and transmitting an etching termination signal to the etch bath.